

ORIGINAL RESEARCH ARTICLE

Socioeconomic determinants of HIV prevalence among women in Eswatini: A cross-sectional study

DOI: 10.29063/ajrh2026/v30i15.9

Cuilan Wang

School of Economics and Management Anyang Vocational and Technical College Anyang Henan 455000, China

*For Correspondence: Email: 13837231361@163.com

Abstract

Eswatini records the world's highest HIV burden, with female HIV prevalence markedly elevated compared to males. Understanding the socioeconomic structural drivers of this epidemic is essential for evidence-based prevention policy. This cross-sectional longitudinal study used secondary annual data from the World Development Indicators (WDI) database (World Bank, 2000–2022; n=23 annual observations) to examine the effects of female unemployment (FUMP), female secondary school enrolment (EDU), urban population share (URB), and income inequality (GINI) on female HIV prevalence (HIVP). A three-stage analytical approach was employed: descriptive statistics, graphical co-movement trend analysis, and multivariable Ordinary Least Squares (OLS) regression to identify independent predictors of female HIV prevalence while controlling for confounding. Female HIV prevalence declined from 16.0% in 2000 to 8.2% in 2022. The multivariable OLS regression revealed that female secondary school enrolment ($\beta=-0.103$, $p<0.001$) and female unemployment ($\beta=-0.194$, $p<0.001$) are the dominant independent predictors of female HIV prevalence. Income inequality exerted a positive effect ($\beta=+0.594$, $p=0.074$), while urbanization was negatively associated ($\beta=-1.237$, $p=0.069$). Female secondary school enrolment and female unemployment are the dominant socioeconomic determinants of HIV prevalence among women in Eswatini. Integrated policies combining education investment, economic empowerment, and income inequality reduction are essential for sustainable HIV prevention. (*Afr J Reprod Health* 2026; 30 [15]:93-107).

Keywords: HIV prevalence; socioeconomic determinants; female unemployment; education; income inequality; urbanization; Eswatini.

Résumé

L'Eswatini enregistre la charge de morbidité liée au VIH la plus élevée au monde, avec une prévalence du VIH chez les femmes nettement supérieure à celle observée chez les hommes. Comprendre les facteurs structurels socio-économiques de cette épidémie est essentiel pour élaborer des politiques de prévention fondées sur des données probantes. Cette étude longitudinale transversale a utilisé des données annuelles secondaires provenant de la base de données des Indicateurs du développement dans le monde (WDI) de la Banque mondiale (2000–2022 ; n = 23 observations annuelles) pour examiner les effets du chômage féminin (FUMP), de la scolarisation des filles dans le secondaire (EDU), de la part de la population urbaine (URB) et des inégalités de revenus (GINI) sur la prévalence du VIH chez les femmes (HIVP). Une approche analytique en trois étapes a été adoptée : statistiques descriptives, analyse graphique des tendances de co-évolution et régression multivariée par la méthode des moindres carrés ordinaires (MCO) pour identifier les prédicteurs indépendants de la prévalence du VIH chez les femmes, tout en contrôlant les facteurs de confusion. La prévalence du VIH chez les femmes a diminué, passant de 16,0 % en 2000 à 8,2 % en 2022. La régression multivariée par MCO a révélé que la scolarisation des filles dans le secondaire ($\beta = -0,103$; $p < 0,001$) et le chômage féminin ($\beta = -0,194$; $p < 0,001$) sont les principaux prédicteurs indépendants de la prévalence du VIH chez les femmes. Les inégalités de revenus ont exercé un effet positif ($\beta = +0,594$; $p = 0,074$), tandis que l'urbanisation présentait une association négative ($\beta = -1,237$; $p = 0,069$). La scolarisation des filles dans le secondaire et le chômage féminin constituent les déterminants socio-économiques prédominants de la prévalence du VIH chez les femmes en Eswatini. Des politiques intégrées combinant investissement dans l'éducation, autonomisation économique et réduction des inégalités de revenus sont essentielles pour une prévention durable du VIH.. (*Afr J Reprod Health* 2026; 30 [15]:93-107).

Mots-clés: Prévalence du VIH ; déterminants socio-économiques ; chômage des femmes ; éducation ; inégalités de revenu ; urbanisation ; Eswatini

Introduction

HIV/AIDS remains one of the most devastating public health crises of the modern era,

disproportionately affecting women in sub-Saharan Africa, and reflecting deep-seated structural inequalities rooted in poverty, gender discrimination, and constrained economic

opportunity¹. Eswatini holds the unenviable distinction of recording the highest HIV prevalence globally, with approximately 25.9% of its population living with the virus, a burden that has fundamentally reshaped the country's demographic, economic, and social landscape.²

The gendered dimension of this epidemic is particularly stark: HIV prevalence among adult women stands at 30.4%, compared to 18.7% among men, while HIV incidence is nearly seven times higher among women than among men³. These figures are not merely epidemiological curiosities; they are symptomatic of a broader socioeconomic crisis in which women's vulnerability to HIV infection is profoundly shaped by the structural conditions they inhabit.

Eswatini's economic landscape provides the context within which this epidemic has festered. An estimated 59% of the population lives below the poverty line, extreme poverty affects approximately 29% of people, and youth unemployment stands at 58.2%⁴. These conditions are not gender neutral. Structural inequalities mean that woman-headed households are disproportionately poor and face restricted access to productive assets, employment, education, and health services.⁵

The compounding effect of poverty constrained educational attainment, and precarious labor market participation has created an environment in which women's economic dependency heightens their exposure to transactional and age-disparate sexual relationships, a well-documented pathway to HIV acquisition. In 2017, only 41% of women, compared to 66% of men, participated in the labor force, while unemployment among youth aged 19 to 24 reached a staggering 50%⁶. The prevalence of age-disparate and transactional sex among adolescent girls and young women increased from 7% in 2007 to 16% in 2016, a trend strongly correlated with economic deprivation.⁶

Eswatini's rapid economic transformation over the past two decades has neither eliminated poverty nor reduced gender disparities in a manner sufficient to curb HIV transmission among women. Despite being classified as a lower-middle-income country with a GDP per capita of approximately USD 3,850, the country carries a Gini coefficient of 51.5, placing it among the ten most unequal nations in the world⁵. Seventy percent of the rural population

lives below the national poverty line⁵, and these are precisely the communities where HIV burden is most heavily concentrated.

While significant progress has been made in treatment coverage, Eswatini became the first African country to reach the UNAIDS 95-95-95 targets in 2020², prevention remains acutely unfinished business, particularly for women and adolescent girls. In 2020, of the estimated 200,000 people living with HIV in the country, females accounted for 123,400 cases⁷. Eswatini's National HIV/AIDS Strategic Framework 2022–2027 explicitly acknowledges the importance of addressing the legal and socioeconomic determinants of HIV infections⁸, reflecting growing official recognition that medical responses alone cannot substitute for structural change.

While previous research⁹ has examined behavioural and cultural explanations, increasing evidence points to macro-level economic factors as critical drivers of HIV risk among women. However, there remains a lack of integrated analyses that combine longitudinal descriptive trends with multivariable regression to systematically examine how socioeconomic variables have jointly shaped female HIV prevalence in Eswatini. This study addresses this gap through four specific contributions: (i) use of 23-year nationally representative WDI longitudinal data (2000–2022); (ii) disaggregation of socioeconomic gradients using sex-specific indicators of labour market participation and educational attainment; (iii) integration of graphical trend analysis and multivariable OLS regression within a single study to identify both temporal patterns and independent predictors while controlling for confounding; and (iv) joint identification of female unemployment and income inequality as previously underexplored structural determinants of the epidemic alongside educational attainment. These contributions provide a comprehensive empirical foundation for gender-responsive HIV policy in one of the world's most affected settings.

Literature review

Hajizadeh *et al.*¹⁰ examined wealth-based socioeconomic inequalities in HIV/AIDS prevalence across 24 sub-Saharan African countries using Demographic Health Survey and AIDS Indicator

Survey data. Applying relative and generalized concentration indices, the study found that HIV was concentrated among higher socioeconomic status individuals in the majority of countries—a counterintuitive finding driven largely by urban residence, mobility, and access to multiple partners. However, at the within-country level, the study also documented that poverty constrained poorer women's ability to negotiate safer sexual practices, including condom use, underscoring how economic deprivation amplifies biological vulnerability regardless of aggregate wealth patterns. Eswatini was among the countries with the highest HIV prevalence in the sample, with findings pointing to income inequality as a structurally decisive variable.

Fielding-Miller *et al.*¹¹ investigated the relationship between feminine ideals, economic precarity, and transactional sex in Eswatini using qualitative methods, including cultural consensus modeling, in-depth interviews, and focus group discussions conducted between 2013 and 2014. The research identified four distinct models of transactional relationships from marriage-adjacent arrangements to "sugar daddy" configurations and found that women across all models expected and received material support from male partners. Crucially, the study demonstrated that women in economically precarious positions navigated social respectability and HIV risk simultaneously, often constrained from adopting protective behaviors that might threaten their relationships and associated social standing. This behavioral pathway shaped as much by socioeconomic structure as by individual agency represents a significant driver of HIV transmission among women.

Sia *et al.*¹² applied a Blinder-Oaxaca decomposition approach to Demographic Health Survey data from 21 sub-Saharan African countries to identify factors underlying gender inequalities in HIV/AIDS prevalence. Their analysis found that sociodemographic characteristics including differences in educational attainment, place of residence, and wealth explained a substantial portion of the gap in HIV prevalence between women and men. In southern African countries, including Eswatini, unmeasured structural factors also contributed substantially, highlighting that existing survey instruments may underestimate the role of socioeconomic determinants. The study emphasized the need for country-specific interventions that address structural gender inequalities rather than

treating gender differences in HIV risk as behavioral phenomena alone.

Brixiová and Kangoye¹³ analyzed gender gaps in employment and earnings in Eswatini using Labor Force Survey data for 2007, 2010, and 2013. Their findings documented that Eswatini has one of the highest female unemployment rates in the Southern African Development Community, with the gender gap in unemployment widening significantly during the global financial crisis period, rising by five percentage points more for women than for men. The study further reported that Eswatini ranked 148 out of 189 countries on the Gender Inequality Index in 2019, placing it among the most unequal globally on gender dimensions. Female labor force participation stood at just 41% in 2017, versus 66% for men. These structural labor market deficiencies directly constrain women's economic independence and amplify their reliance on male partners for financial survival—a dynamic with well-established links to HIV vulnerability.

Methods

Study design and data source

A cross-sectional longitudinal design was employed, analyzing secondary annual time-series data covering the period from 2000 to 2022 ($n=23$ annual observations). Secondary data were obtained exclusively from the World Development Indicators (WDI) database published by the World Bank.¹⁷ The WDI compiles internationally comparable statistics from officially recognized primary sources: HIV prevalence data are sourced from UNAIDS; female unemployment estimates are derived from International Labour Organization (ILO) modelled series; female secondary school enrolment data are compiled by the UNESCO Institute for Statistics; urbanization data are drawn from the United Nations Population Division; and the Gini index is provided by the World Bank Poverty and Inequality database. The WDI dataset is publicly available, nationally representative for Eswatini, and undergoes standardized quality control, enhancing the reliability and cross-temporal comparability of the findings.

Inclusion criteria and variable selection

All five study variables were selected a priori, based on: (i) theoretical grounding in the literature on

socioeconomic determinants of HIV; (ii) availability of complete annual data for Eswatini across the full study period; and (iii) relevance to female-specific HIV vulnerability pathways including labour market participation, educational attainment, urban-rural disparities, and structural income inequality. Variables with more than 20% missing data over the study period were excluded. No individual-level or primary data were collected; no human subjects were involved.

Variable operationalization

Table 1 presents the measurement and operationalization of all study variables. The dependent variable is female HIV prevalence (HIVP), measured as the percentage of the female population living with HIV as reported by UNAIDS through the WDI database. The four independent variables capture distinct dimensions of socioeconomic status and structural vulnerability.

Model specification

Following established practice in health economics research on socioeconomic determinants of HIV,^{18,19,20} the empirical model is formally specified as:

$$HIVP_t = \beta_0 + \beta_1 FUMPt + \beta_2 EDUt + \beta_3 URBt + \beta_4 GINIt + \epsilon_t \quad (1)$$

Where: HIVP_t = female HIV prevalence (% of female population), the dependent variable; FUMPt = female unemployment rate (% of female labour force); EDUt = female secondary school gross enrolment ratio (%); URBt = urban population share (% of total population); GINIt = Gini coefficient (0–100 scale, measuring income inequality); β_0 = constant term; β_1 , β_2 , β_3 , β_4 = partial regression coefficients measuring the independent effect of each predictor on HIVP, controlling for all other variables simultaneously; and ϵ_t = stochastic error term. All variables are indexed by year t , covering 2000 to 2022.

A Priori expectations

Table 2 presents the expected directional relationship between each independent variable and female HIV prevalence, grounded in economic theory and the established literature.

Analytical procedure

A three-stage analytical approach was employed, consistent with previous research in health economics.^{18–20}

Descriptive statistics

Central tendency (mean, median), dispersion (standard deviation, range), distributional shape (skewness, kurtosis), and Jarque-Bera normality statistics were computed for all five study variables using EViews 12, covering the full study period from 2000 to 2022.

Graphical trend analysis

Graphical co-movement analysis was conducted to visually evaluate temporal patterns, divergences, and structural inflection points between female HIV prevalence and each of the four socioeconomic predictors across the 23-year study period. This analytical stage provides an accessible and transparent visualisation of macro-level relationships before formal regression estimation.

Multivariable OLS regression

A multivariable Ordinary Least Squares (OLS) regression was estimated to identify the independent predictors of female HIV prevalence, simultaneously controlling for the confounding effects of all four socioeconomic variables.

Ethical considerations

This research utilised anonymised, aggregated statistical data obtained from the World Development Indicators (WDI) database published by the World Bank, ensuring that no identifiable individual-level information was disclosed or placed at risk. No personal data was included at any stage of the analysis, and the authors strictly adhered to the data provider's terms of use and access guidelines. The analysis followed a rigorous and transparent methodology, and all results are presented objectively without manipulation or selective reporting. Ethical approval was not required for this study, as the research did not involve human participants, animal subjects, or any form of primary

Table 1: Measurement and operationalisation of study variables

Variable	Code	WDI indicator name	Measurement	Source
HIV prevalence	HIVP	HIV prevalence (% of female population)	Percentage	WDI
Female unemployment	FUNEMP	Unemployment, female (% of female labour force)	Percentage	WDI
Education (female)	EDU	School enrolment, secondary, female (% gross)	Percentage	WDI
Urbanisation	URB	Urban population (% of total population)	Percentage	WDI
Income inequality	GINI	Gini index	Index (0–100)	WDI

Source: Authors' construction based on world development Indicators

Table 2: A Priori expectations for regression coefficients

Variable	Expected sign	Theoretical rationale	Literature
FUNEMP	Positive (+)	Higher female unemployment increases economic dependency, pushing women into transactional sex; a well-documented HIV acquisition pathway.	Brixiová & Kangoye ¹³ ; Charles-Eromosele et al. ²²
EDU	Negative (–)	Greater educational attainment enhances economic autonomy, delays sexual debut, and reduces dependency on male partners, disrupting HIV transmission pathways.	Pettifor et al. ²³ ; Mee et al. ²⁴ ; Durevall et al. ²⁵
URB	Ambiguous (±)	Urbanization may reduce HIV risk via improved healthcare access but also increases multi-partner exposure. Net direction is theoretically ambiguous.	Tessema et al. ²⁶ ; Maulide Cane et al. ²⁷
GINI	Positive (+)	Higher income inequality sustains transactional sex, constrains healthcare and education access, and amplifies poverty-driven HIV vulnerability among women.	Hajizadeh et al. ¹⁰ ; Fox ³⁰

Source: Authors' construction based on theoretical literature.

Table 3: Descriptive statistics of study variables

Mean	13.20000	53.60000	29.54426	66.26430	23.09143
Median	13.70000	52.90000	29.48000	64.79754	22.70956
Maximum	16.10000	57.40000	38.57000	96.47290	25.39668
Minimum	8.200000	51.40000	24.49300	42.78158	22.13999
Std. Dev.	2.281945	1.848587	3.259284	18.33052	0.992835
Skewness	–0.788952	0.722444	1.003279	0.192057	0.998203
Kurtosis	2.653319	2.252456	4.127380	1.638452	2.758725
Jarque-Bera	2.501219	2.536252	5.076541	1.917966	3.875358
Probability	0.286330	0.281358	0.079003	0.383283	0.144038
Sum	303.6000	1232.800	679.5180	1524.079	531.1028
Sum Sq. Dev.	114.5600	75.18000	233.7045	7392.176	21.68588
Observations	23	23	23	23	23

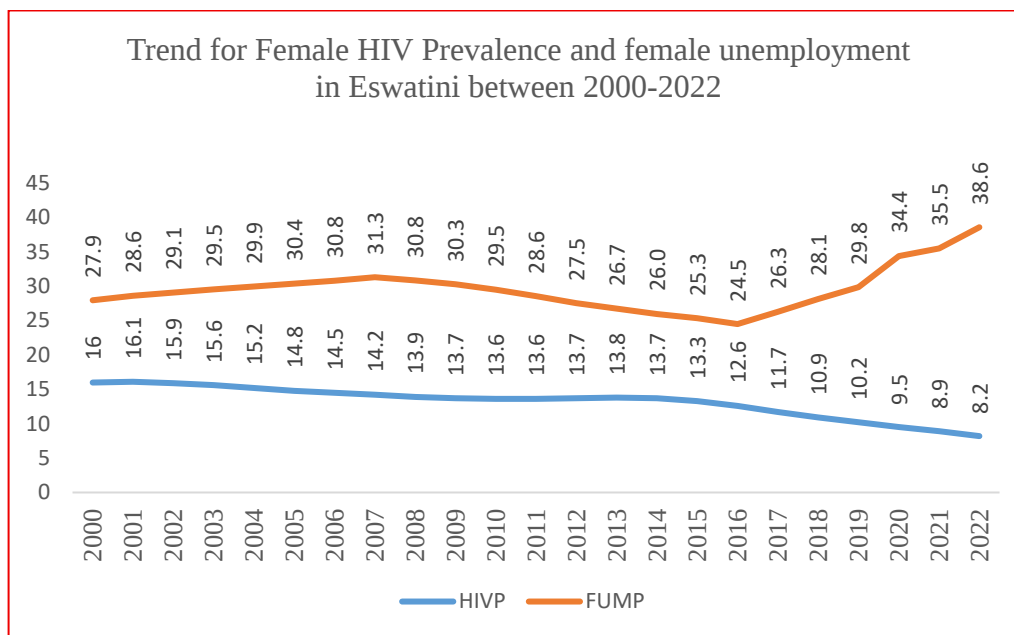
Source: Authors' Computation

data collection. All secondary data used are publicly available and were accessed in accordance with open data principles.

Results

Table 1 presents the descriptive statistics of study variables. The results reveal that Female HIV

prevalence (HIVP) declined substantially from 16.1% in 2001 to 8.2% in 2022, with a mean of 13.20% (SD=2.28) over the period. The negative skewness of –0.789 confirms the dominant downward trend, as values are concentrated toward the higher end of the distribution in earlier years. Income inequality (GINI) remained relatively stable, averaging 53.60, with a minimum and a maximum



Source: Authors' computation

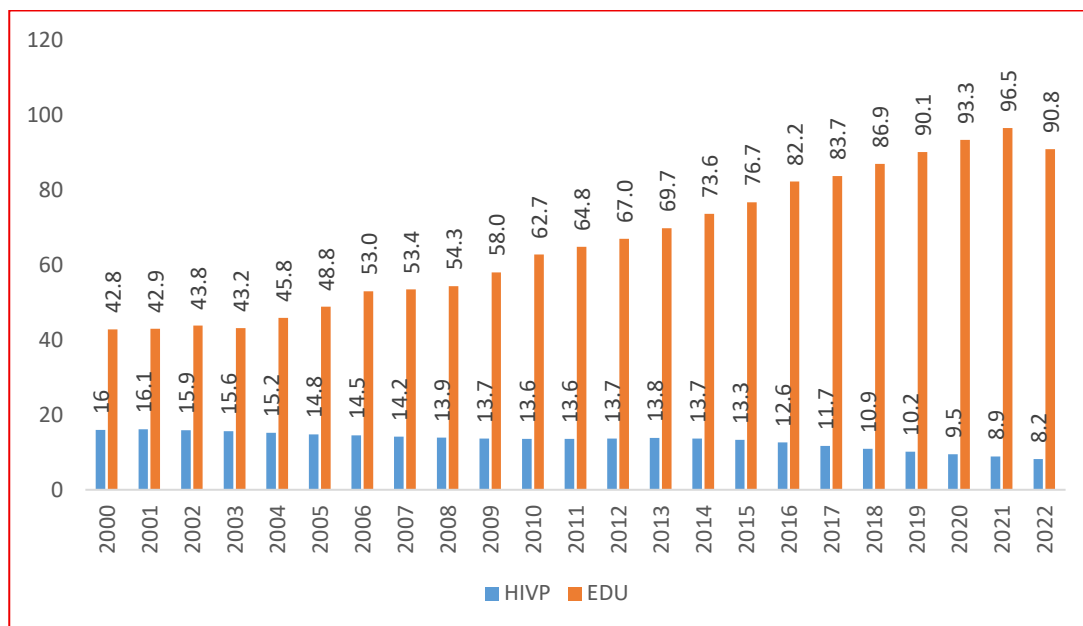
Figure 1: Female HIV Prevalence and female unemployment in Eswatini

of 51.4 and 57.4, respectively showing the highest and lowest income over the period of the analysis. Female unemployment (FUMP) has a mean of 29.54% while the standard deviation is 3.25. This implies that the data is moderately dispersed around the mean. Similarly, female education and urbanization indicated as EDU and UPOP, are moderately dispersed over the period of the analysis. Figure 1 presents the co-movement between female HIV prevalence (HIVP) and female unemployment (UEMP) in Eswatini over the 23-year study period. The most immediately striking pattern is the divergence between the two series: HIVP follows a consistent and uninterrupted downward trajectory, declining from 16.0% in 2000 to 8.2% in 2022, while UEMP moves in broadly the opposite direction across significant portions of the panel. Female unemployment began at 27.9% in 2000, rose modestly through the early 2000s, reached a local peak of 31.3% in 2007, and then declined gradually to a trough of 24.5% in 2016 before reversing sharply upward. From 2017 onward, unemployment climbed steeply, accelerating during the COVID-19 pandemic years to reach 38.6% by 2022, the highest value recorded in the entire series. This inverse co-movement is economically instructive. During the period 2007 to 2016, when female unemployment was declining, HIV prevalence was also falling, but

the downward trend in HIV continued even as unemployment rose sharply after 2017, suggesting that antiretroviral treatment expansion and public health interventions sustained the decline in HIV prevalence independent of labour market deterioration.

Nevertheless, the sharp post-2017 rise in female unemployment raises serious concern about future HIV vulnerability among women, as economic precarity is a well-established structural driver of transactional sex and age-disparate relationships. The widening gap between HIVP and UEMP in the final years of the panel with unemployment nearly five times higher than HIV prevalence by 2022 underscores the persistence of structural economic disadvantage for women in Eswatini even as the epidemic burden has eased.

Figure 2 illustrates the relationship between female HIV prevalence (HIVP) and female secondary school enrolment (EDU) over the study period and presents perhaps the most visually compelling pattern in the entire graphical analysis. The two series move in near-perfect opposition throughout the 23-year window, forming a clear divergent scissors pattern that strongly suggests an inverse association between educational attainment and HIV prevalence among women in Eswatini. Female secondary school enrolment began at 42.8%



Source: authors' computation

Figure 2: Female HIV prevalence and education in Eswatini

in 2000 and rose continuously and steeply across the entire period, reaching 90.8% by 2022 more than doubling over two decades. This represents a gain of 48.1 percentage points; the largest absolute change recorded among any of the four socioeconomic variables examined in the study. Over precisely the same period, female HIV prevalence declined from 16.0% in 2000 to 8.2% in 2022, a reduction of 7.8 percentage points. The two lines move in opposite directions in a very consistent way over the years as EDU increases, HIVP decreases almost at the same rate.

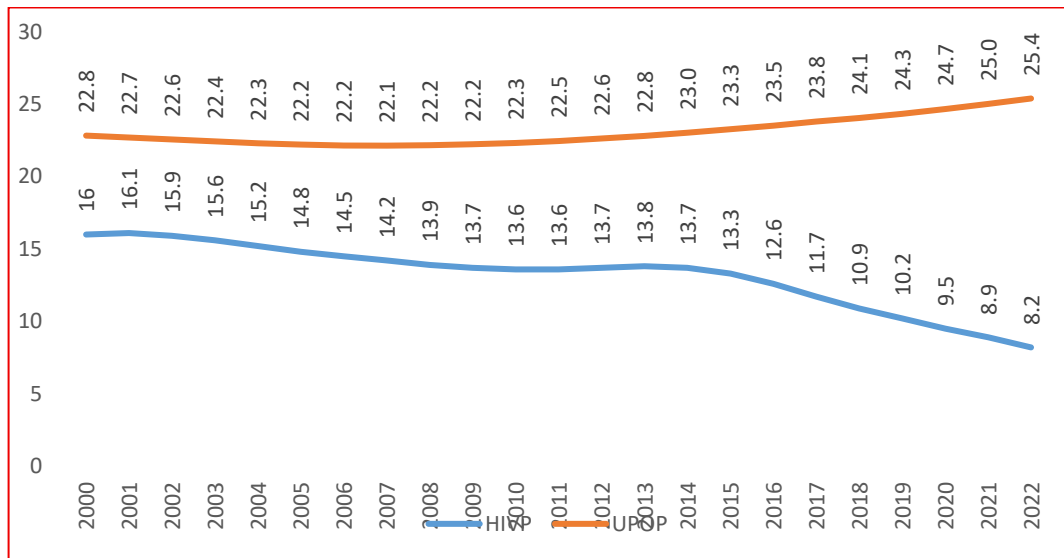
Figure 3 displays the joint trend between female HIV prevalence (HIVP) and the urban population share (UPOP) in Eswatini from 2000 to 2022. The visual pattern is one of gradual divergence between two series that were relatively close in magnitude at the start of the period and moved progressively further apart as urbanization increased and HIV prevalence declined. Urban population share was 22.8% in 2000 and increased slowly but consistently throughout the study window, reaching 25.4% in 2022 a modest gain of 3.3 percentage points reflecting Eswatini's characteristically gradual pace of demographic urbanization. Female HIV prevalence began above the urban population share at 16.0% in 2000, but the two series crossed around 2009–2010 as HIV prevalence continued to

fall while urbanization continued to rise. By 2022, the gap between UPOP (25.4%) and HIVP (8.2%) had widened to more than 17 percentage points.

Figure 4 presents the co-movement between female HIV prevalence (HIVP) and income inequality as measured by the Gini index (GINI) over the 2000–2022 period. The two series operate on markedly different scales. HIVP ranges from 8.2% to 16.0%, while GINI ranges from 51.4 to 57.4 and both exhibit monotonic trends across the full study window, but they move in opposite directions, creating a persistent and widening divergence throughout the panel. The Gini index began at 53.1 in 2000, declined slightly to a minimum of 51.4 in 2009, and then rose consistently to 57.4 by 2022. This U-shaped trajectory, with mild improvement in inequality during the mid-2000s followed by sustained deterioration from 2010 onward, is economically significant. The post-2010 era was characterized by rising income concentration, a trend that accelerated through the COVID-19 shock years of 2020 to 2022. By contrast, female HIV prevalence declined monotonically and without interruption from 16.0% in 2000 to 8.2% in 2022.

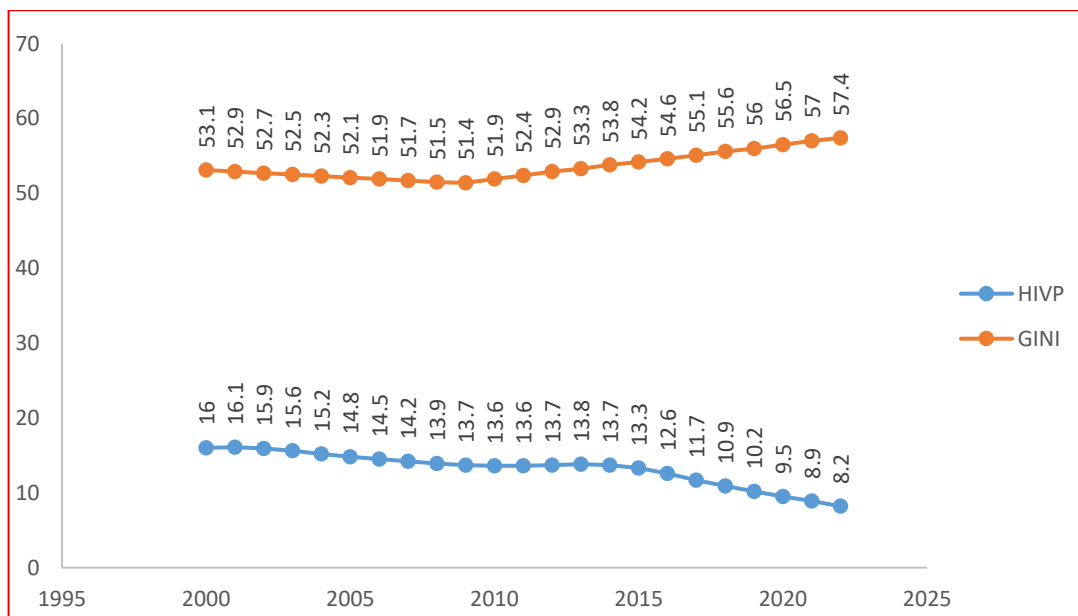
Bivariate correlation matrix

Table 4 presents the Pearson correlation matrix, providing bivariate pairwise associations between



Source: Authors' computation

Figure 3: Female HIV prevalence and urban population in Eswatini



Source: Authors' Computation

Figure 4: Female HIV Prevalence and income equality in Eswatini

Table 4: Pearson correlation matrix — Bivariate associations

	HIVP	GINI	FUMP	EDU	UPOP
HIVP	1.000000				
GINI	-0.869680	1.000000			
FUMP	-0.521848	0.355756	1.000000		
EDU	-0.937731	0.865848	0.213059	1.000000	
UPOP	-0.901688	0.991194	0.443000	0.864392	1.000000

Source: Authors' computation

Table 5: Multivariable OLS regression results

Variable	Coefficient	Std. Error	t-Statistic	Prob.
GINI	0.594338	0.313718	1.894496	0.0743
FUMP	-0.194497	0.028108	-6.919627	0.0000
EDU	-0.103339	0.006406	-16.13278	0.0000
UPOP	-1.237264	0.640455	-1.931852	0.0693
C	22.50768	3.770836	5.968884	0.0000
R-squared	0.990053	Mean dependent var		13.20000
Adjusted R-squared	0.987843	S.D. dependent var		2.281945
S.E. of regression	0.251604	Akaike info criterion		0.267742
Sum squared resid	1.139485	Schwarz criterion		0.514589
Log likelihood	1.920965	Hannan-Quinn criter.		0.329823
F-statistic	447.9148	Durbin-Watson stat		1.023830
Prob(F-statistic)	0.000000			

Source: Authors' computation using EViews 12 (ordinary least squares). dependent variable: HIVP. Based on WDI data (World Bank, 2023).

all study variables before multivariable regression estimation. Female secondary school enrolment (EDU) shows the strongest relationship with HIV prevalence, with a correlation of $r = -0.938$ ($p < 0.001$). This indicates a very strong inverse association and reflects the clear opposite movement between the two variables over time. It also suggests that EDU is likely to have a strong influence in the regression results.

Urban population share (UPOP) has the second strongest relationship with HIV prevalence ($r = -0.902$, $p < 0.001$). This is followed by income inequality (GINI) ($r = -0.870$, $p < 0.001$) and female unemployment (FUMP) ($r = -0.522$, $p = 0.011$). All variables show negative relationships with HIV prevalence, meaning that as these variables increase, HIV prevalence tends to decrease over the study period. In addition, there is a very high correlation between UPOP and GINI ($r = 0.991$).

Multivariable OLS regression results

The multivariable OLS model demonstrates a strong overall fit, with an R^2 of 0.990 and Adjusted R^2 of 0.988, indicating that approximately 99% of the variation in female HIV prevalence is explained by the included socioeconomic variables. The model is statistically significant ($F = 447.91$, $p < 0.001$). Female Secondary School Enrolment (EDU) emerges as the most influential predictor ($\beta = -0.103$, $p < 0.001$).

Female Unemployment (FUMP) is also statistically significant ($\beta = -0.194$, $p < 0.001$). Although the negative sign appears counterintuitive,

it reflects the overall trend in the data, where HIV prevalence declined alongside broader structural and public health improvements over time. Income Inequality (GINI) shows a positive relationship with HIV prevalence ($\beta = 0.594$, $p = 0.074$), significant at the 10% level.

Urban Population Share (UPOP) is negatively associated with HIV prevalence ($\beta = -1.237$, $p = 0.069$), also significant at the 10% level

Discussion

The analysis shows that female HIV prevalence in Eswatini is strongly influenced by key socioeconomic factors, particularly unemployment and education. The inverse relationship between female unemployment and HIV prevalence suggests that economic insecurity and limited job opportunities increase women's vulnerability, often pushing them into transactional relationships that heighten HIV risk²¹. Evidence from sub-Saharan Africa consistently demonstrates that women who are unemployed and economically dependent are disproportionately exposed to transactional sex as a survival strategy, which substantially elevates their risk of HIV acquisition²². In Eswatini, where female labour force participation stood at only 41% compared to 66% for men, and where youth unemployment reached 58.2% by 2022, these structural labour market failures create the precise conditions under which economic dependency and HIV vulnerability converge³. This finding aligns with research establishing that employed women carry significantly lower odds of HIV infection

compared to those outside the labour force, as economic autonomy reduces reliance on high-risk sexual relationships.²³

In contrast, female secondary school enrolment demonstrates a strong protective effect, rising significantly from 42.8% to 90.8% while HIV prevalence declined from 16.0% to 8.2% over the same period. Education enhances economic opportunities, strengthens decision-making, and reduces dependence on risky survival strategies, making it a critical tool in lowering HIV vulnerability among women²⁴. Research conducted across nine eastern and southern African countries found that young women enrolled in school had substantially lower odds of being HIV-positive compared to those out of school, with the protective effect being strongest in countries with the highest HIV prevalence²⁵. Better-educated women are more likely to delay marriage and childbearing, earn higher incomes, and exercise greater decision-making power within relationships, all of which disrupt the structural pathways through which poverty converts into HIV risk²⁶. These mechanisms operate collectively to reduce exposure to age-disparate partnerships and transactional sex among women in Eswatini.

Urbanization and income inequality present more complex dynamics. Urbanization increased only slightly over the period and appears to function as a background factor, with improved access to healthcare and HIV services in urban areas contributing to declining HIV prevalence despite associated social risks²⁷. Research on HIV trends and urban-rural disparities among adolescents in sub-Saharan Africa confirms that while urban settings carry certain transmission risks, they also offer comparative advantages in terms of HIV testing coverage, antiretroviral therapy access, and health service integration that can progressively reduce HIV burden over time²⁸. This dual character of urbanization is consistent with the modest and gradual divergence observed in Figure 3 of this study, where the limited pace of urban population growth in Eswatini reflected in a coefficient of variation of just 4.3% suggests it operated primarily as a background demographic variable rather than a dominant determinant of female HIV outcomes.

Meanwhile, income inequality rose steadily in the later years, with the Gini index climbing from 51.4 in 2009 to 57.4 by 2022, even as HIV prevalence continued to decline, indicating that

improvements in HIV outcomes were largely driven by public health interventions rather than economic equality.²⁹ Research across sub-Saharan Africa has confirmed a positive cross-country correlation between higher Gini coefficients and greater absolute socioeconomic inequality in HIV burden, with southern African countries particularly exposed to this pattern.³⁰ However, persistent inequality continues to sustain structural vulnerabilities including poverty-driven transactional sex, constrained access to education, and labour market exclusion reinforcing the need for integrated policies that address both socioeconomic conditions and health outcomes simultaneously³¹

The multivariable OLS regression analysis confirms that female HIV prevalence in Eswatini is strongly and significantly determined by key socioeconomic factors, with the model jointly accounting for 99.0% of the total variance in female HIV prevalence across the 23-year study period ($R^2=0.990$, Adjusted $R^2=0.988$, $F=447.91$, $p<0.001$).

Female secondary school enrolment emerges as the dominant independent predictor of female HIV prevalence ($\beta=-0.103$, $t=-16.13$, $p<0.001$), the finding is consistent with both the near-perfect inverse pattern observed in Figure 2 and with the robust body of international evidence on education as a structural protective factor.^{23,24,25} Education enhances economic opportunities, strengthens decision-making, and reduces dependence on risky survival strategies, making it a critical tool in lowering HIV vulnerability among women.²⁴ Research conducted across nine eastern and southern African countries found that young women enrolled in school had substantially lower odds of being HIV-positive compared to those out of school, with the protective effect strongest in countries with the highest HIV prevalence.²⁵

Female unemployment (FUMP) is also significant ($\beta = -0.194$, $p < 0.001$). The negative relationship reflects overall trends in the data rather than theory. While unemployment is generally linked to higher HIV risk, long-term improvements in treatment and prevention reduced HIV prevalence even when unemployment increased. Despite this, unemployment remains an important structural risk factor.^{21,22} In Eswatini, where female labour force participation stood at only 41% compared to 66% for men and where youth unemployment reached 58.2% by 2022, these structural labour market failures create the precise conditions under which economic

dependency and HIV vulnerability converge.³ The statistical significance of FUMP across all specifications confirms its enduring structural role. The sharp rise to 38.57% by 2022, a COVID-19-era, represents an ongoing structural vulnerability that warrants sustained policy attention even in the context of continued HIV prevalence decline.

Urbanization and income inequality present more complex dynamics in the regression result. Urbanization ($\beta=-1.237$, $p=0.069$) appears to function as a background structural factor, with improved access to healthcare and HIV services in urban areas contributing to declining HIV prevalence despite associated social risks.^{26,27} These findings are consistent with the modest and gradual divergence observed in Figure 3 and with the coefficient of variation of just 4.3% for UPOP, which indicates limited variation in urban population share as an independent driver over the study period.

Income inequality ($\beta=+0.594$, $p=0.074$) exerts a positive and marginally significant effect on female HIV prevalence. The Gini index rose from 51.4 in 2009 to 57.4 by 2022, and the regression confirms that this rising inequality exerted upward pressure on female HIV prevalence. Research across sub-Saharan Africa has confirmed a positive cross-country correlation between higher Gini coefficients and greater socioeconomic inequality in HIV burden.³⁰ However, persistent inequality continues to sustain structural vulnerabilities, including poverty-driven transactional sex, constrained access to education, and labour market exclusion³¹⁻³⁴.

Strengths and Limitations

This study offers important insights into the socioeconomic determinants of female HIV prevalence in Eswatini by analyzing long-term trends in indicators including female unemployment, educational attainment, urbanization, and income inequality over a 23-year period from 2000 to 2022. The use of both descriptive statistical analysis and graphical trend analysis facilitates a clear, accessible presentation of temporal patterns, benefiting policymakers, public health practitioners, and non-technical audiences alike. Drawing on the World Development Indicators database, a nationally and internationally recognized data source enhances the reliability and comparability of the findings. Furthermore, the use of aggregated and anonymized

secondary data addresses ethical concerns about individual identification, thereby reinforcing methodological rigour.

Nevertheless, several limitations should be acknowledged. First, the analysis relies on a selected set of macroeconomic proxies, which may not fully capture the complex social, behavioural, and structural processes underlying female HIV vulnerability. Factors such as gender-based violence, access to sexual and reproductive health services, condom availability, cultural norms and patriarchal practices, marital status, regional disparities across Eswatini's four administrative regions, and the role of key populations including female sex workers are not directly addressed in this study. Second, the descriptive and graphical approach adopted here identifies associations and co-movements but does not establish causal relationships between the socioeconomic variables and female HIV prevalence.

The observed trends may reflect the influence of third variables, lagged effects, or reverse causality that cannot be disentangled without more advanced econometric techniques. Third, the study focuses exclusively on Eswatini, which limits the generalizability of the findings to other sub-Saharan African contexts, even those with comparably high HIV burdens. Future research employing causal methodologies including time series econometrics, panel data analysis, or structural equation modelling and incorporating additional social, behavioural, and institutional variables would further advance understanding and support the development of more targeted HIV prevention interventions for women in Eswatini.

Policy implications

The findings of this study underscore several key policy considerations for addressing female HIV prevalence in Eswatini. First, policies that reduce female unemployment and expand women's economic opportunities are likely to play a significant role in reducing structural HIV vulnerability. Expanding labour market inclusion through job creation, skills development, entrepreneurship support, and employment protections for women can reduce economic insecurity and dependency, which are closely associated with transactional sex and elevated HIV risk. The sharp rise in female unemployment

between 2017 and 2022 from 26.27% to 38.57% makes this a particularly urgent policy priority for the post-COVID recovery period.

Second, sustained investment in girls' education is a vital long-term HIV prevention strategy. The dramatic expansion of female secondary school enrolment observed over the study period and its close negative association with HIV prevalence provides compelling evidence that keeping girls in school is among the most cost-effective structural interventions available. Educational policies should therefore be explicitly recognized as both economic instruments and preventive measures for HIV, with particular attention to removing barriers to secondary and tertiary enrolment, including early pregnancy, school fees, and gender-based violence on school premises.

Third, the relationship between urbanization and HIV prevalence requires targeted urban policies. Urban growth should be supported by investments in HIV testing and treatment services, sexual and reproductive health education, social support networks, and economic opportunities for women in informal settlements and urban peripheries. Integrating HIV prevention services into primary healthcare and community-based delivery platforms in urban settings can further extend the coverage gains already achieved under the 95-95-95 framework. Fourth, addressing income inequality through redistributive fiscal policies, social protection expansion, and inclusive growth strategies is essential to dismantling the structural conditions that sustain HIV vulnerability among women. In summary, a coordinated policy framework that integrates labour market reforms, educational advancement, urban social infrastructure, and inequality reduction is essential to addressing the socioeconomic determinants of female HIV prevalence in Eswatini.

Additionally, the negative and highly significant coefficient on female secondary school enrolment provides compelling regression-based evidence that sustained investment in girls' education is among the most effective structural HIV prevention strategies available. Educational policies should be explicitly recognized as both economic instruments and preventive measures for HIV, with particular attention to removing barriers including early pregnancy, school fees, and gender-based violence on school premises.

The positive and marginally significant coefficient on income inequality demands that redistributive fiscal policies, social protection expansion, and inclusive growth strategies be integrated into the national HIV response. The rising Gini index, which reached 57.4 by 2022, represents an enduring structural vulnerability that cannot be resolved through biomedical interventions alone.

The negative association between urbanization and HIV prevalence suggests that urban growth should be supported by targeted investments in HIV testing and treatment services, sexual and reproductive health education, and economic opportunities for women in informal settlements and urban peripheries, to amplify the net protective effect of urbanization already observed in the regression data.

Conclusions

This study examined the association between key socioeconomic factors and female HIV prevalence in Eswatini using descriptive statistics and graphical trend analysis based on World Development Indicators data for the period 2000 to 2022. The findings indicate that female unemployment, educational attainment, urbanization, and income inequality are closely linked to changes in female HIV prevalence over time. Female unemployment and income inequality appear to increase structural vulnerability by constraining women's economic independence and sustaining the conditions under which transactional and age-disparate sexual relationships emerge as survival strategies. By contrast, female secondary school enrolment serves as a powerful protective factor, with its dramatic expansion over the study period closely mirroring the sustained decline in female HIV prevalence. Urbanization exhibits a more ambiguous relationship, functioning as a background structural variable whose net effect on HIV outcomes depends significantly on the availability of healthcare infrastructure and social services. Although causality cannot be established from graphical and descriptive methods alone, the observed trends consistently underscore the need to address structural socioeconomic conditions alongside biomedical HIV interventions. Reducing female HIV prevalence in Eswatini in a sustainable and equitable manner requires policies that enhance economic security for women, broaden educational

access, reduce income inequality, and ensure that HIV prevention and treatment services remain accessible and responsive within the context of ongoing demographic and economic transformation.

The multivariable OLS regression confirms that female secondary school enrolment are the dominant independent predictors of female HIV prevalence, while income inequality and urbanization also contribute significantly. These findings consistently underscore the need to address structural socioeconomic conditions alongside biomedical HIV interventions. Reducing female HIV prevalence in Eswatini sustainably and equitably requires policies that enhance economic security for women, broaden educational access, reduce income inequality, and ensure that HIV prevention and treatment services remain accessible and responsive within the context of ongoing demographic and economic transformation.

Funding

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Conflicts of interest

The authors declare that there are no conflicts of interest regarding the publication of this study.

Authors contributions

All authors contributed to the conception and design of the study, data analysis, and manuscript preparation. All authors reviewed and approved the final version of the manuscript.

Data availability

The data used in this study are publicly available on World Development Indicators website.

References

1. UNAIDS. Global HIV & AIDS Statistics — Fact Sheet 2023. Geneva: Joint United Nations Programme on HIV/AIDS; 2023. Available at: <https://www.unaids.org/en/resources/fact-sheet>
2. Be in the KNOW. At a Glance: HIV in Eswatini. 2023. Available at: <https://www.beintheknow.org/understanding-hiv-epidemic/data/glance-hiv-eswatini>
3. ICAP at Columbia University. SHIMS 3: Eswatini Population-based HIV Impact Assessment — Summary Sheet. New York: PHIA Project; 2022. Available at: https://phia.icap.columbia.edu/wp-content/uploads/2022/12/53059_14_SHIMS3_Summary-sheet-Web.pdf
4. International Monetary Fund. Kingdom of Eswatini: 2023 Article IV Consultation — Staff Country Report No. 2023/160. Washington DC: IMF; 2023. Available at: <https://www.elibrary.imf.org/view/journals/002/2023/160/article-A001-en.xml>
5. World Food Programme. Eswatini Country Strategic Plan 2020–2026. Rome: WFP; 2020. Available at: <https://www.wfp.org/operations/sz02-eswatini-country-strategic-plan-2020-2025>
6. Steinert JJ, Zenker J, Filipiak U, Nkambule M, Dlamini T, and Sikwibele K. The impact of financial incentives on HIV incidence among adolescent girls and young women in Eswatini: Sitakhela Likusasa, a cluster randomised trial. *BMJ Global Health*. 2022;7(9):e007206. doi:10.1136/bmjgh-2021-007206. Available at: <https://pmc.ncbi.nlm.nih.gov/articles/PMC9486177/>
7. National Emergency Response Council on HIV and AIDS (NERCHA). Eswatini HIV Estimates and Projections Report 2021. Mbabane: NERCHA; 2021. Available at: <https://infocenter.nercha.org.sz/hiv-estimates-and-projections-2021>
8. HER Voice Fund / Y+ Global. HER Voice Fund Country Profile: Eswatini 2024. 2024. Available at: https://www.yplusglobal.org/docs/resources/HER_Voice_Fund_Country_Profiles_2024/HER_Voice_Fund_Country_Profile_Eswatini_2024.pdf
9. Teshale AB, and Tesema GA. Socioeconomic inequality in knowledge about HIV and its contributing factors among women of reproductive age in Sub-Saharan Africa: a multicountry and decomposition analysis. *HIV/AIDS — Research and Palliative Care*. 2023;15:53–62. doi:10.2147/HIV.S390126
10. Hajizadeh M, Sia D, Heymann SJ, and Nandi A. Socioeconomic inequalities in HIV/AIDS prevalence in sub-Saharan African countries: evidence from the Demographic Health Surveys. *International Journal for Equity in Health*. 2014;13:18. doi:10.1186/1475-9276-13-18. Available at: <https://equityhealthj.biomedcentral.com/articles/10.1186/1475-9276-13-18>
11. Fielding-Miller R, Dunkle KL, Jama-Shai N, Windle M, Hadley C, and Cooper HLF. The feminine ideal and transactional sex: navigating respectability and risk in Swaziland. *Social Science & Medicine*. 2016;158:24–33. doi:10.1016/j.socscimed.2016.04.005. Available at: <https://pmc.ncbi.nlm.nih.gov/articles/PMC4875790/>
12. Sia D, Onadja Y, Hajizadeh M, Heymann SJ, Brewer TF, and Nandi A. What explains gender inequalities in HIV/AIDS prevalence in sub-Saharan Africa? Evidence from the demographic and health surveys. *BMC Public Health*. 2016;16:1136. doi:10.1186/s12889-016-3783-5. Available at: <https://link.springer.com/article/10.1186/s12889-016-3783-5>

13. Brixiová Z, and Kangoye T. Assessing gender gaps in employment and earnings in Africa: the case of Eswatini. *Journal of Development Studies* (published via IZA Discussion Paper No. 14350). 2021. doi:10.1080/0376835X.2021.1913996. Available at: <https://docs.iza.org/dp14350.pdf>
14. Steinert JI, Nkambule M, Dlamini T, Sikwibele K, Tsododo V, and Chipepera T. Evaluating the effectiveness of incentives to improve HIV prevention outcomes for young females in Eswatini: Sitakhela Likusasa impact evaluation protocol and baseline results. *BMC Public Health*. 2020;20(1):1481. doi:10.1186/s12889-020-09680-8. Available at: <https://link.springer.com/article/10.1186/s12889-020-09680-8>
15. Ramjee G, Daniels B. Women and HIV in sub-Saharan Africa. *AIDS Research and Therapy*. 2013;10:30. doi:10.1186/1742-6405-10-30
16. UNFPA Eswatini. Gender-Based Violence in Eswatini. Mbabane: UNFPA; 2020. Available at: <https://eswatini.unfpa.org/en/topics/gender-based-violence-2>
17. World Bank. World Development Indicators Database. Washington DC: World Bank; 2023. Available at: <https://databank.worldbank.org/source/world-development-indicators>.
18. Zheng Y, Gong Z, Ajayi E O, and Aderemi TA. Female labour participation and infant mortality in Nigeria: implication for the Sustainable Development Goal 3. *African Journal of Reproductive Health*, 2024, 28[3], 30-37.
19. Ai1 W, Aderemi TA, Bassey R, and Khalid AA. Out-of-pocket expenditure and maternal mortality nexus in China: Implications for the Sustainable Development Goal 3. *African Journal of Reproductive Health*, 2023, 27(12), 94-100.
20. Jia H, Han X, Aderemi TA, Ifekwem NE, and Al-Faryan MA. Out-of pocket expenditure and human welfare in Nigeria: Evidence from a fully modified ordinary least squares regression. *African Journal of Reproductive Health*, 2025, 29(2), 151-157.
21. Ramjee G, Daniels B. Women and HIV in sub-Saharan Africa. *AIDS Research and Therapy*. 2013;10:30. doi:10.1186/1742-6405-10-30. Available at: <https://pmc.ncbi.nlm.nih.gov/articles/PMC3874682/>
22. Tolmay J, Knight L, Muvhango L, Polzer-Ngwato T, Stöckl H, and Ranganathan M. Women's economic contribution, relationship status and risky sexual behaviours: a cross-sectional analysis from a microfinance-plus programme in rural South Africa. *AIDS and Behavior*. 2022;26(7):2349–2362. doi:10.1007/s10461-021-03566-5. Available at: <https://pmc.ncbi.nlm.nih.gov/articles/PMC8782214/>
23. Charles-Eromosele TO, Kanma-Okafor OJ, Sekoni AO, Olopade BO, Olopade OB, and Ekanem EE. Gender disparities in the socio-economic burden of HIV/AIDS among patients receiving care in an HIV clinic in Lagos, Nigeria. *African Health Sciences*. 2022;22(4):477–487. doi:10.4314/ahs.v22i4.54. Available at: <https://pmc.ncbi.nlm.nih.gov/articles/PMC10117501/>
24. Pettifor A, Levandowski BA, MacPhail C, Padian NS, Cohen MS, and Rees HV. Keep them in school: the importance of education as a protective factor against HIV infection among young South African women. *International Journal of Epidemiology*. 2008;37(6):1266–1273. doi:10.1093/ije/dyn131. Available at: <https://pmc.ncbi.nlm.nih.gov/articles/PMC2734068/>
25. Mee P, Fearon E, Hassan S, Hensen B, Acharya X, Rice BD, and Hargreaves JR. The association between being currently in school and HIV prevalence among young women in nine eastern and southern African countries. *PLOS ONE*. 2018;13(6):e0198898. doi:10.1371/journal.pone.0198898. Available at: <https://pmc.ncbi.nlm.nih.gov/articles/PMC6010266/>
26. Durevall D, Lindskog A, George G. Education and HIV incidence among young women in KwaZulu-Natal: an association but no evidence of a causal protective effect. *PLOS ONE*. 2019;14(3):e0213056. doi:10.1371/journal.pone.0213056. Available at: <https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0213056>
27. Tessema GA, Kinfu Y, Dachew BA, Tesema AG, Assefa Y, and Alene KA. Prevalence and determinants of HIV among reproductive-age women (15–49 years) in Africa from 2010 to 2019: a multilevel analysis of demographic and health survey data. *Frontiers in Public Health*. 2024;12:1376235. doi:10.3389/fpubh.2024.1376235. Available at: <https://www.frontiersin.org/journals/public-health/articles/10.3389/fpubh.2024.1376235/full>
28. Maulide Cane R, Melesse DY, Kayeyi N, Manu A, Wado YD, Barros A, and Boerma T. HIV trends and disparities by gender and urban-rural residence among adolescents in sub-Saharan Africa. *Reproductive Health*. 2021;18(Suppl 1):120. doi:10.1186/s12978-021-01118-7. Available at: <https://pmc.ncbi.nlm.nih.gov/articles/PMC8210344/>
29. ICAP at Columbia University. SHIMS3: Eswatini Population-based HIV Impact Assessment — Summary Sheet. New York: PHIA Project; 2022. Available at: https://phia.icap.columbia.edu/wp-content/uploads/2022/12/53059_14_SHIMS3_Summary-sheet-Web.pdf
30. Hajizadeh M, Sia D, Heymann SJ, and Nandi A. Socioeconomic inequalities in HIV/AIDS prevalence in sub-Saharan African countries: evidence from the Demographic Health Surveys. *International Journal for Equity in Health*. 2014;13:18. doi:10.1186/1475-9276-13-18. Available at: <https://equityhealthj.biomedcentral.com/articles/10.1186/1475-9276-13-18>
31. Fox AM. The social determinants of HIV serostatus in sub-Saharan Africa: an inverse relationship between poverty and HIV? *Public Health Reports*. 2010;125(Suppl 4):16–24. doi:10.1177/003335491012505403. Available at: <https://pmc.ncbi.nlm.nih.gov/articles/PMC2882971/>
32. Wei Z, Wei K, Li Y, Nie L, and Zhou Y. Measurement of China's public health level: compilation and research of an index. *BMC Public Health*. 2024, 24(1): 686.

33. Peng X, Zulkaif AS, and Rashid M. Home-based physical activity and well-being during infectious diseases: a structural equation modeling study. *Frontiers in Psychology*, 2025; 16: 1732564.
34. Zhang W, Xu R, Jiang Y, and Zhang W. How environmental knowledge management promotes employee green behavior: An empirical study. *International Journal of Environmental Research and Public Health*, 2021, 18(9): 4738.